Induced Negative Mood and the Positivity Effect

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Abstract

Older adults sometimes demonstrate a bias in memory for positive over negative stimuli, referred to as a positivity bias. In contrast, young adults demonstrate the opposite bias and remember more negative than positive stimuli. This resultant combination of biases results in a phenomenon called the positivity effect, which is, in short, manifested by a negative correlation between age and the proportion of negative stimuli remembered There is also a mood congruence effect on memory, such that individuals who are exposed to positive, negative, and neutral material while in a particular mood will later remember better the material that was congruent with their mood at the time of learning. The present study sought to determine whether inducing a negative mood in participants prior to engaging them in a recognition memory task would in any way modify the memory biases previously discussed. For young adults, the negativity bias was not demonstrated. Similarly, for older adults, the positivity bias was not demonstrated. Instead, for both groups, the data suggest an "anti-positivity" bias, with roughly equivalent memory performance for negative and neutral items and relatively worse memory for positive items. Furthermore, the data suggest that, although the negative mood induction procedure had a significant effect on self-reported affective state, there is no evidence of mood congruent memory.

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The Positivity Effect

A myriad of empirical examinations of emotional functioning and experience during late life have soundly challenged the bleak characterization of old age as a time of emotional dysregulation and affective flattening. Largely speculative early theories about emotional experience in older adulthood painted a picture of cool rationality, greater negative affectivity, and emotional detachment (e.g., Henry & Cumming, 1959). Contrary to these initial conjectures, on the whole, current research supports a more optimistic view. Recent findings indicate that there is, at the very least, stability in emotional experience, if not developmental gains. Based on a detailed exploration of daily emotional experience across the lifespan, Laura Carstensen and her colleagues discovered that older adults feel positive emotions just as frequently as young adults and, up until the age of 60, experience fewer negative emotions in their day-to-day activities (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Gross, Carstensen, Pasupathi, Tsai, Skorpen, & Hsu, 1997). Moreover, the negative emotions that older adults *do* experience are less persistent than those of young adults (Fernandes, Ross, Wiegand, & Schryer, 2008). Relative to their younger counterparts, older adults control their emotions more effectively, speak of and think about their emotions in more sophisticated and integrative ways, and report that emotions play a key, central role in their daily lives (Carstensen & Turk-Charles, 1994; Gross, Carstensen, Pasupathi, Tsai, Skorpen, & Hsu, 1997). These convergent findings illustrate that emotional experience and expression are relatively spared with increasing age, unlike many cognitive and health domains that show marked functional decline (e.g., Salthouse, Bialystok, & Craik, 2006).

The increasing ratio of positive to negative emotions across the lifespan has several potential explanations. With stronger control over and understanding of the emotions one experiences, one might actively select situations that maximize positive experiences and minimize or dampen the impact of aversive experiences. A theory that encompasses exactly that notion is socioemotional selectivity theory (SST; Carstensen, Fung, & Charles, 2003; Carstensen, Isaacowitz, & Charles, 1999). It holds that, as time is perceived to be more limited, more emphasis is placed on emotionally meaningful goals rather than on novelty-seeking or knowledge-gathering goals. When concerns for the future become less relevant, an individual's focus shifts towards optimizing current feeling-states.

Socioemotional selectivity theory has three central tenets. First is that social interactions are critical for survival; second, humans are goal-striving, and the anticipated realization of those goals drives their behavior at any time; finally, individuals must select the goals they wish to fulfill before acting upon them. Additionally, SST holds that the diverse range of social goals can be placed into one of two functional categories: the pursuit of knowledge and the regulation of emotion. At every moment, these two goal types compete with one another for fulfillment; an individual's assessment of time remaining is critical in determining which goal an individual ultimately pursues. Late in life, with an ultimate end looming, older adults are more likely to move through their social environment maximizing positive experiences and interactions and minimizing negative ones (Carstensen, Isaacowitz, & Charles, 1999). Technically, the shift in motivation described by SST is not ontogenetic. It is not aging as a process in itself that brings about increased focus on emotional goals; it is the perception of limited time.

Since chronological age is inextricably associated with time left in life, however, an age-related phenomenon does emerge (Carstensen, Isaacowitz, & Charles, 1999). As an explanation for older adults' motivation to seek out positive experiences, SST has strong empirical validity. Furthermore, it offers specific predictions about the content of older adults' memories, particularly emotionally-laden memory, as will be discussed later.

A thorough study of the effect of aging on increased memory for emotional stimuli revealed that there are not systematic age-related changes in emotion-enhanced memory (Denburg, Buchanan, Tranel, & Adolphs, 2003): individuals, regardless of age, show enhanced memory for emotional stimuli over neutral stimuli. The average *valence* of information stored in memory, however, does appear to change with age. Multiple controlled laboratory studies have shown that young adults remember negative information better than neutral information (e.g., Fung, Lu, Goren, Isaacowitz, Wadlinger, & Wilson, 2008; Rozin & Royzman, 2001; Langeslag & van Strien, 2009). This result is related to the phenomenon of negativity dominance, which asserts that negative stimuli have a greater impact on cognition than neutral or positive stimuli. Negativity dominance is explained in evolutionary terms; negative stimuli are often more adaptively informative, especially in the context of predation and danger avoidance (Fung, Lu, Goren, Isaacowitz, Wadlinger, & Wilson, 2008). Negativity dominance has been replicated in studies of young adults, but the same studies fail to find this effect in older adults (Rozin & Royzman, 2001). Instead, studies have identified a reduced advantage in memory for negative material in older adults, and in some cases, a *positivity bias*. The Age X Valence interaction that results when older adults show this bias in memory for positive material is termed an age-related *positivity effect*.

The positivity effect is, in short, a negative correlation between age and the relative number of negative images recalled, after viewing images that vary in affective valence (Charles, Mather, & Carstensen, 2003; Carstensen & Mikels, 2005). This lifespan change (the positivity *effect*) can emerge from a number of possible scenarios involving different kinds of memory biases (positivity or negativity *biases*). A positivity bias is a discrete phenomenon, observed within one age group, in which there is increased processing of positive information (Langeslag & van Strien, 2009). Three patterns of biases can result in a positivity effect: when younger adults show no bias and older adults show a positivity bias; when younger adults show a negativity bias and older adults show no bias; and when younger adults show a negativity bias and older adults show a positivity bias (Langeslag & van Strien, 2009, p. 369) Additionally, this age difference is augmented with delay between time of encoding and time of retrieval; older adults were more likely to forget previously recalled negative images than previously recalled positive images when retrieval was repeated 48 hours after initial encoding and retrieval (Mather & Knight, 2005). This enhanced positivity effect is taken to indicate that older adults perform more elaborative processing when retrieving positive images as compared to negative images.

In order to demonstrate that the positivity effect is truly a result of motivation rather than an effect of aging, Xing and Isaacowitz (2006), using a sample composed entirely of young adults, showed that individuals explicitly motivated to regulate their emotions attended less to negative images than positive images when compared to individuals given no viewing instructions. Technically, the study found evidence of negativity avoidance in attention rather than a positivity bias, but the findings nonetheless provide support for the assertion that motivation can influence attentional processes. Gruhn, Scheibe, and Baltes (2007) and Langeslag and van Strien (2009) also contend that the positivity bias is more accurately termed a "reduced negativity effect." In both of their experiments, young adults demonstrated a memory bias for negative images, while older adults hardly showed any difference in memory for negative, positive, or neutral images, indicating that the effect is a result of a decreased tendency in older adults to process negative information.

In order to demonstrate that the positivity bias in older adults' emotional memory is not associated with cognitive decline, Mather and Knight (2005) conducted an investigation relating cognitive control and emotional memory. Indeed, those older adults who were most likely to show the positivity bias were those who scored highest on measures of cognitive control. When participants were distracted by a concurrent task during encoding, older adults' positivity bias disappeared (Mather & Knight, 2005, Experiment 3). This shows that older participants in the control condition employed their attentional resources during picture presentation to help them remember positive images better than negative ones in a way that young adults did not.

Even though older adults do not have the same arsenal of processing resources that young adults do, multiple experiments show that older adults are adept at allocating what resources they *do* have in a way that is consistent with their chronically activated emotion regulation goals. Knight et al. (2007) conducted a study to investigate whether or not the chronic accessibility of emotional goals would affect visual fixation patterns. They found that in circumstances that allowed all potential resources to be put towards fulfilling emotional goals, the positivity effect was indeed expressed, in older adults visual attention preference for positive over negative or neutral stimuli. When participants were in a divided attention condition, however, older adults' positivity bias was reversed; they were more likely to fixate on negative stimuli when distracted (Knight, Seymour, Gaunt, Baker, Nesmith, & Mather, 2007). This study provides good evidence that older adults do indeed actively modify and direct their behavior to control how their environment affects them and also that the positivity effect can be modified or eliminated under some conditions. Plainly, an individual's motivations have a strong impact on attention and memory.

Mood Congruent Memory

Age-related motivation change is obviously not the only force acting on cognition, however. Affective states also have bearing on what an individual pays attention to and remembers (Rholes, Riskind, & Lane, 1987). One of the phenomena linking emotion and memory is mood congruence. It "implies that the efficiency of mnemonic processing is biased by the congruence between an existing mood and the affective tone of the material involved" (Blaney, 1986, p. 231). The basic effect has been replicated many times over since the 1970's, using a variety of mood induction procedures and memory tasks, including film clips, lists of emotional statements, and hypnotism (Alexander & Guenther, 1986; Clark & Teasdale, 1985; Ehrlichman & Halpern, 1988; Fielder, Nickel, Muehlfriedel, & Unkelbach, 2001; Gerrards-Hesse, Spies, & Hesse, 1994; Isen, Shalker, Clark, & Karp, 1978; Natale & Hantas, 1982; Rholes, Riskind, & Lane, 1987; Rusting & DeHart, 2000; Teasdale & Fogarty, 1979).

There is a fundamental but nuanced distinction between mood congruent memory and mood-dependent memory. In the case of mood congruent memory, the affective valence of the material to be remembered makes it more or less likely to be encoded and/or retrieved when one is in a particular mood. Being in the same mood during encoding and retrieval is not necessary. Mood-dependent memory does not depend on the affective valence of the material; it implies that what one learns in a given mood can be best remembered when one is returned to that mood (Blaney, 1986). Demonstrating true mood-dependent recall is more challenging than demonstrating simple mood congruence, and some of the studies claiming to have elicited the former are arguably only demonstrating the latter (Eich, 1995; Blaney, 1986).

A widely accepted model to explain the phenomenon of mood congruence is the associative network and spreading-activation theory (Bower, 1981), originally proposed in cognitive psychology to describe encoding and retrieval of long-term memory (Anderson, 1983). The theory, as it has been modified to apply to mood and memory, supposes that every mood has its own specific, discrete node in memory that connects to events in one's life during which that particular mood was experienced. Being in a particular mood activates that mood's node and serves as a retrieval cue that spreads activation to events to which that mood has been associated in the past (Bower, 1981; Isen, Shalker, Clark, & Karp, 1978). Items with a similar associative history are supposed to be connected by strong paths in the network. Pleasant stimuli receive greater activation from positive moods than negative moods, which makes mood-congruent (in this case, positive) stimuli more likely to enter consciousness and be retrievable (Fielder, Nickel, Muehlfriedel, & Unkelbach, 2001).

Mood congruence has been determined not to be a result of demand characteristics (Alexander & Guenther, 1986), such as when participants selectively report memories or mood states, based on expectations or experimenter cues, or a heuristic response tendency to only report memories that match one's current mood (Fielder, Nickel, Muehlfriedel, & Unkelbach, 2001). Mood congruence has also been found in studies that sought to minimize the cognitive activity associated with the experience of a mood (by inducing mood with odors), indicating that mood congruence is not simply an effect of cognition on memory but instead a true effect of mood on memory (e.g., Ehrlichman & Halpern, 1988). These studies make the assumption that inducing mood through odors does not engage the same arsenal of cognitive resources that inducing mood through watching film clips or reading emotional statements do.

Despite the confirmation of mood congruence as a sound, replicable memory phenomenon, there are still constraints on its inducibility and universality. Clark and Teasdale (1985) found that females demonstrated a stronger differential effect of depressed mood on the retrieval of positive and negative memories; they also showed, however, that women, in their past experience, had more frequently activated the concepts related to the study's negative word stimuli than men did (for example, they reported higher daily usage ratings for the negative words than men did), giving them an "advantage" with regard to their pre-established associative network for negative moods and stimuli. Extended retention intervals (several hours to several days) also attenuate the effect of mood on retrieval (Bower, 1981). Mood dependent retrieval is also most likely to occur when the target memories are of internal events (those produced by participants through mental processes, like imagination) rather than external events (those provided to participants by the experimenter, like a word list), when the retrieval task has minimal observable cues or reminders (like a free recall paradigm), and when both levels of pleasure *and* arousal are manipulated by the mood induction task (Eich, 1995). Finally, it appears that there is not symmetry in the respective effects of positive and negative mood states on memory. Participants in induced depressed moods often recall fewer target items overall than participants in neutral or elated mood states (Ellis, Thomas, McFarland, & Lane, 1985; Teasdale & Fogarty, 1979).

Clearly, there are a large number of studies independently examining the positivity effect and mood congruence. Presently, both of these phenomena are believed to be genuine and replicable, but the positivity effect, in particular, is somewhat ephemeral in the literature (for a review, see Fernandes, Ross, Wiegand, & Schryer, 2008). I suggest, that there may be an explanation for this lack of robustness, one that links mood congruence and the positivity effect directly. As of this point in time, there are no studies simultaneously investigating mood congruence and the positivity effect. This is, potentially, an oversight by previous investigators and a hole in the current literature. Mood congruence and the positivity effect may, in a way, subtly interact to determine what items people remember. Even if an investigator is not directly assessing mood congruence or inducing particular moods, the moods that participants carry into the session or which are accidentally induced during the course of a session may influence what items they remember, and thereby, modify biases that they would have demonstrated in a neutral mood.

The present study sought to further the understanding of the positivity effect by including a mood induction procedure in an otherwise ordinary investigation of emotional memory. To this end, I conducted a within-subject experiment. I induced a general negative mood in each participant and subsequently assessed their performance on a recognition memory task. I also induced a neutral or mildly positive mood in the same participants and again assessed their performance on a similar recognition memory task. By comparing the emotional character of participants' memory in each mood condition, I hoped to describe a set of circumstances under which younger and older adults' memory biases could be modified.

Methods

Participants

Participants for this experiment were 15 young adults, between the ages of 18 and 22 (M = 20.18 years, SD = 1.44, 8 female) and 14 older adults between the ages of 60 and 78 (M = 70.00, SD = 6.12, 6 female). Two additional young adults were excluded from analyses, due to missing data or a low rate of correct rejections (below 60%). Of the young adults, 12 were White, 2 were Asian, and 1 was Hispanic. All older adults were White. All participants, except 1 young adult and 1 older adult, were right-handed. I attempted to recruit two sample populations matched for education level (young adults, M = 14.76 years, SD = 1.28; older adults, M = 16 years, SD = 2.11; $t(29) = 2.02$, p = 0.07). Young adults were recruited from introductory psychology courses at the Georgia Institute of Technology and offered extra course credit in exchange for participation. Older adults residing in the Atlanta metropolitan area were recruited from a research volunteer database established by the sheltering laboratory. Older adult participants were remunerated $5 for every half-hour of participation. A self-report health questionnaire was administered to all participants to ensure that they were not taking any drugs that would hamper their cognitive functioning, experiencing any physical or psychological illnesses that would affect their memory performance (i.e., untreated depression, seizure disorders, any form of dementia, a history of stroke, previous brain damage), or afflected by any severe, uncorrected vision impairments (i.e., cataracts, untreated glaucoma, macular degeneration). Additionally, all participants were screened for symptoms of depression using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), since depression has been related to sensitivity to mood induction (Scherrer & Dobson, 2009) and accessibility of negative memories and cognitions (Ellis, Thomas, McFarland, & Lane, 1985). Participants were included in analyses only if their score on the CES-D fell below 20 on the 20-item version since scores above 20 may be evidence of depression. Appendix A demonstrates the CES-D questionnaire as it was presented to participants.

Apparatus

The experiment was conducted on Dell Vostro 200 desktop personal computers with the E-Prime application suite (Psychology Software Tools, Pittsburgh, PA) installed. Participants sat in standard office chairs approximately 3.5 feet away from the monitor. The table was at such a height to allow the monitor to rest at eye-level. Participants used the Ergodex DX1 Input System with three labeled buttons to enter their responses, and the system tablet was placed in their laps during computer tasks. I used a montage of short film clips to induce a generalized negative mood. The clips included selections from the movies *Pink Flamingos* (Waters, 1972), *The Champ* (Lovell & Zeffirelli, 1979), and *Creepshow* (Hassnein, Rubinstein, & Romero, 1982), as well as a realistic demonstration of a Civil-War-era amputation (Finley-Holiday Films, 2009). Still captures from the negative mood film montage are shown in Figure 1. The length of the negative clip montage was 4 min and 45 s. These clips have been previously piloted and determined to elicit emotions such as disgust and sadness (Gross & Levenson, 1995; Stark, Schienle, Sarlo, Palomba, Walter, & Vaitl, 2005). Eliciting emotions using film clips can result in high emotional intensity and complexity with moderate ecological validity and standardization across sessions (Rottenberg, Ray, & Gross, 2007). I also used a montage of film clips of similar total length (4 min and 47 s) to induce a neutral or mildly positive mood in participants. The neutral clip montage included footage of a bear cub foraging in a wooded area (Wyoming Photo Experience, 2007), footage of Senator Paul Kirk's 2009 swearing-in ceremony (C-SPAN, 2009), and footage from a short, black-and-white educational documentary called, "The Nature of Sound" (Coronet Instructional Films, 1948). Still captures from the neutral mood film montage are shown in Figure 2. The clips in the neutral montage were chosen due to their similarity to clips previously piloted and determined to induce a neutral or mildly positive mood (Fucito & Juliano, 2009; Gomez, Zimmermann, Guttormsen-Schar, & Danuser, 2009).

The visual stimuli presented during the memory task consisted of 274 digitized color photographs taken from the International Affective Picture System (IAPS; Bradley & Lang, 2007) with 206 additional images, piloted and normalized by Newsome and Duarte (in preparation). The precise image numbers for all of the IAPS stimuli used in the current study are listed in Appendix C. Images were chosen on the basis of young and older adults grouping them in the same valence category (positive, negative, and neutral) and reporting similar ratings of arousal. Since the IAPS images were originally normalized using only young adults, the present study employed the arousal and valence ratings provided in the more recent paper by Gruhn and Scheibe (2008) which normalized many of the IAPS images using older adult subjects. The present study included 160 images from each valence category, for a total of 480 images. A breakdown of the arousal ratings for the photographs included in the study is shown in Table 1. A diagram representing the percentages of images which fell into each of four content categories (i.e., person, object, scene/landscape, and animal; the criteria for these categories are detailed in Bradley & Lang, 2007) and into each of the three valence categories is presented in Figure 3.Sample negative, neutral, and positive photographs are shown in Figures 4, 5, and 6, respectively.

Design

The study was a 2 x 3 x 2 within-subject experimental design with two independent variables: Mood Induction and Image Valence, and one between-subjects variable, Age. Memory performance, broken down by Image Valence, was compared between the two Mood Induction conditions within each subject and also broken down by Age.

Procedure

After participants signed documents indicating their informed consent, they sat in front of the computer and listened to verbal instructions regarding the task, including a warning about the aversive nature of some of the images and film clips. The experimenter assured all participants that they were free to leave the experiment session at any time without penalty. Participants performed two practice demonstrations of the computer tasks ahead (one for the study portion, the other for the test portion); these were intended to allow participants to adjust to the task demands and the response input procedure. Next, participants filled out the twenty-item Positive and Negative Affect Schedule

(PANAS; Watson & Clark, 1994; Watson, Clark, & Tellegen, 1988), to assess affective state at the beginning of the session. Appendix B contains the PANAS questionnaire as it was presented to participants. Participants then watched one of the film clip montages, either the neutral or negative one, determined by counterbalancing, while the experimenter was out of the room. Upon the experimenter's return to the room the end of the clip, participants again filled out the PANAS, with the explicit instruction to indicate how they felt *in that moment*, regardless of what they had responded previously. Participants then performed the first computer portion of the experiment, using the E-Prime program containing 120 of the 240 images selected for study, with image presentation order counterbalanced among participants. The images were presented one at a time, at a rate of 1 image per 750 ms, in the center of the screen against a white background. A black fixation cross appeared at the center of the screen for 3 s between each image. During the study block, participants were instructed to decide whether each image represented an *indoor* or *outdoor* scene or object and indicate their judgment by pressing one of two keys on the input tablet. This question was chosen because it resulted in a roughly even distribution of images to the two categories, "indoor" and "outdoor," as judged by the experimenter. A visual representation of the study portion the experiment is shown in Figure 7. Immediate following completion of the study block, participants then performed the corresponding test portion of the task. The same 120 images presented previously, plus 120 novel images, were presented. Presentation rate was the same as it was in the study portion of the task: 750 ms for each image, with a 3 s fixation cross between images. Participants were instructed to press the '1' key on the input tablet if they had seen the image previously, to press the '2' key if it was a new image, and to press the ‘3’ key if they were not sure whether or not they had seen the image. A visual representation of the test portion the experiment is shown in Figure 8. After completion of the test block, participants then performed selected tasks from the Memory Assessment Scales (Williams, 1991), performed trail-making tasks A and B, performed three letter fluency tasks, and completed the CES-D questionnaire. Upon completion of these measures, participants filled out the PANAS for a third time. Next, participants viewed the film clip montage not already shown, under the same circumstances described previously. Afterwards, participants filled out the PANAS for the fourth and final time. Participants then performed the second study portion of the experiment, using the E-Prime program containing the other 120 images selected for study, and after completion of this study block, performed the second final test block, using the E-Prime program containing those 120 images just seen plus 120 novel images. Finally, the experimenter debriefed and compensated participants. A simplified timeline for the events of each experiment session is presented in Figure 9.

Results

Mood Induction

Self-report scores on the 20-item PANAS questionnaire were used to determine the efficacy of the mood induction procedure. The PANAS is composed of 10 “positive” items (i.e., Interested, Excited, Strong, Enthusiastic, Proud, Alert, Inspired, Determined, Attentive, and Active) and 10 “negative items” (i.e., Distressed, Upset, Guilty, Scared, Hostile, Irritable, Ashamed, Nervous, Jittery, and Afraid), each placed on a 1 to 5 Likert scale. Two subscores are calculated: one for positive affect and another for negative affect. These are computed by adding the individual item scores for every item in a category (either positive or negative).

In general, older adults reported significantly greater positive affectivity (higher positive affect subscores) than did young adults, throughout the course of the session, [$F(1, 27) = 9.35$, $p = 0.005$]. Reported negative affectivity (negative affect subscores) did not differ between age groups, however, $F(1, 27) = 2.62$, $p = 0.12$.

The data suggest that the mood induction procedure affected older and younger adults in functionally comparable ways. The two groups do not show any significant differences in their mean positive or negative PANAS subscore *changes* (calculated by subtracting each pre-montage subscore from its corresponding post-montage subscore) after viewing either the neutral or negative film montages (all p values > 0.10). In other words, the *arithmetic difference* between participants' post-montage state and participants' pre-montage state is very similar for older and younger adults. For this reason, all participants, regardless of age, will be considered as a whole in the following analyses. For demonstration purposes, however, a breakdown of average PANAS subscores by age group can be seen in Table 2. Moreover, mean change in PANAS subscores, from the pre-viewing state to the post-viewing state for both film montages, can be viewed in Figure 10.

Mood induction, neutral montage.

There was no significant difference between the average negative-item subscore *prior to* ($M = 12.07$, $SD = 3.87$) or *directly following* ($M = 12.17$, $SD = 5.09$) the neutral mood induction procedure, [$t(28) = -0.15$, $p = 0.884$]. The average positive-item subscore *prior to* the neutral mood induction procedure ($M = 30.86$, $SD = 8.07$) was significantly higher than it was *directly following* the neutral mood induction procedure (M = 27.97, SD = 1.80), however, [t(28) = 2.54, p = 0.017]. Finally, positive affectivity, as represented by the positive-item subscore, was significantly higher than negative affectivity, as represented by the negative-item subscore, directly following the neutral mood induction, [t(28) = 8.05, p < 0.001].

Mood induction, negative montage.

The average negative-item subscore *prior to* the negative mood induction procedure (M = 11.93, SD = 2.60) was significantly lower than it was *directly following* the negative mood induction procedure (M = 15.79, SD = 5.03),[t(28) = -4.62, p < 0.001]. Furthermore, the average positive-item subscore *prior to* the negative mood induction procedure (M = 31.03, SD = 9.21) was significantly higher than it was *directly following* the negative mood induction procedure (M = 25.89, SD = 9.97),[t(28) = 4.44, p < 0.001]. However, positive affectivity, as represented by the positive-item subscore, was still significantly higher than negative affectivity, as represented by the negative-item subscore, directly following the negative mood induction, [t(28) = 4.47, p < 0.001]. Comparing across the two induction procedures, the negative montage (M = 15.79, SD = 5.04) resulted in significantly higher negative affect than the neutral montage (M = 12.17, SD = 5.09), as represented by the negative-item subscore on the PANAS directly following each mood induction procedure, [t(28) = 3.96, p < 0.001]. Finally, neither positive nor negative affectivity differed significantly at any time point between participants who saw the negative montage first and participants who saw the neutral montage first (all p values > 0.10), suggesting that carryover effects from the negative montage are unlikely.

On the whole, the data suggest that the negative montage increased negative affectivity and decreased positive affectivity, as judged by participants' self-reports on the PANAS. Furthermore, the data suggest that the neutral montage decreased positive affectivity to some degree but left negative affectivity unaffected.

Memory Performance

Table 3 displays means and standard deviations for item memory accuracy, where accuracy is defined as the proportion of hits (the number of times a participant correctly endorsed an old image as old, divided by the total number of old images presented at test) minus the proportion of false alarms (the number of times a participant incorrectly endorsed a new image as old, divided by the total number of new images presented at test). "Don't know" judgments were excluded from analyses. An Age (young, old) X Mood Induction (neutral, negative) X Image Valence (positive, negative, neutral) ANOVA for item memory accuracy indicates that there was a main effect of Age, [$F(1, 27) = 10.95$, $p = 0.003$], such that young adults demonstrated greater memory accuracy; a main effect of Image Valence, [$F(2, 54) = 11.49$, $p < 0.001$]; and no main effect of Mood Induction, $F(1, 27) = 0.36$, $p = 0.55$. There were also no significant interaction effects (all p values > 0.10). To determine the source of the main effect of valence, Mood Induction (neutral, negative) X Image Valence (neutral, negative; neutral, positive; negative, positive) follow-up ANOVAs were conducted. They indicate that item memory accuracy for negative items was greater than for positive items, [$F(1, 28) = 7.20$, $p = 0.01$] and greater for neutral items than for positive items, [$F(1, 28) = 24.02$, $p < 0.001$]. There is no significant difference between item memory accuracy for negative and neutral items, however, [$F(1, 28) = 2.85$, $p = 0.10$]. Figure 11 displays item memory accuracy, as a function of age and image valence, collapsed across mood induction conditions.

An additional Age (young, old) X Mood Induction (neutral, negative) X Image Valence (positive, negative, neutral) X Decision Category (hit, false alarm) ANOVA was conducted to investigate the possibility that there was a positivity effect inherent in the false alarms of young and older adults. This time, there was no main effect of Age, [$F(1, 27) = 4.13$, $p = 0.06$]; there was a main effect of Image Valence, [$F(2, 54) = 3.85$, $p = 0.03$]; and there was no main effect of Mood Induction, [$F(1, 27) = 0.28$, $p = 0.60$] or any interaction effects (all p values > 0.10). Because there was no Age X Image Valence interaction, and therefore no evidence for a positivity effect, no follow-up ANOVAs were conducted.

Reaction Time

To determine whether or not mood induction or image valence had any effects on reaction time at test, an Age (young, old) X Mood Induction (neutral, negative) X Image Valence) x 4 (Decision Category) ANOVA was conducted. Decision Category here simply denotes whether an item was a hit (i.e., correctly endorsed as old), miss (i.e. incorrectly endorsed as new), correct rejection (i.e., correctly endorsed as new), or false alarm (i.e., incorrectly endorsed as old) at test. The ANOVA indicates that there is a main effect of Age, such that older adults were faster to respond [$F(1, 9) = 8.64$, $p = 0.02$]; no main effect of Image Valence, [$F(2, 18) = 2.30$, $p = 0.14$]; and no main effect of Mood Induction, [$F(1, 9) = 0.08$, $p = 0.78$]. There are also no significant interaction effects (all p values > 0.10).

To determine whether or not mood induction or image valence had any effects on reaction time at study, an Age (young, old) X Mood Induction (neutral, negative) X Image Valence (positive, negative, neutral) x Decision Category (hit, miss) ANOVA was conducted. (The two levels of Decision Category are here hit and miss, since the analysis is considering reaction times *at study* for all old items presented at test.) The ANOVA indicates that there is a main effect of Image Valence, [$F(2, 34) = 8.35$, $p = 0.001$]; no main effect of Age, [$F(1, 17) = 3.69$, $p = 0.07$]; and no main effect of Mood Induction, [$F(1, 17) = 1.57$, $p = 0.23$]. There are also no significant interaction effects (all p values > 0.10). To determine the source of the main effect of valence, Mood Induction (neutral, negative) X Image Valence (neutral, negative; neutral, positive; negative, positive) X Decision Category (hit, miss) follow-up ANOVAs were conducted. They indicate that reaction time at study for negative items is greater than for neutral items, [$F(1, 18) = 5.83$, $p = 0.03$] and also greater for negative items than for positive items, [$F(1, 19) = 23.87$, $p < 0.001$]. There is no significant difference between reaction times at study for neutral and positive items, however, [$F(1, 23) = 3.27$, $p = 0.08$]. Figure 12 displays mean reaction times at study, broken down by age and image valence.

CES-D and Neuropsychological Task Scores

CES-D scores did not differ significantly between younger ($M = 11.13$, $SD = 5.63$) and older adults ($M = 9.07$, $SD = 4.92$), [$F(1, 27) = 1.096$, $p = 0.305$]. Additionally, no participant scored high enough on the CES-D (above 20) to be excluded from analyses. Finally, mean scores, broken down by age group, for the MAS tasks, trail-making tasks, and letter fluency tasks are delineated in Table 4.

Discussion

Because there is no Age X Image Valence interaction effect for memory accuracy, false alarm rates, or reaction times, it must be concluded that the current study found no evidence for the positivity effect in any of the behavioral measures considered. That is, the data suggest that the valence of images remembered has no correlation with age. Even though there is no evidence for the negativity or positivity biases, there is preliminary evidence for some kind of "anti-positivity" bias in both age groups, evidenced by relatively worse memory for positive items as compared to neutral and negative items. At present, I have not uncovered any singular explanation for this unusual pattern, but there are a few plausible accounts.

The apparent memory bias could be actually due to some systematic difference between the images used in the current study and images used in previous studies investigating emotional phenomena in memory. The present study utilized not only extensively piloted IAPS images but also somewhat limitedly piloted images, from Newsome & Duarte (in preparation). It is possible that these relatively untried images have valence or arousal ratings that represent the average judgments of a small sample, rendering them limited in their generalizability. For example, images given the label of neutral by the sample examined by Newsome & Duarte may be given the label of negative or positive by a larger, more representative sample, making it difficult to perform a valid analysis based on image valence. Furthermore, the images were selected for the current study solely on the basis of having arousal and valence ratings that were equivalent for older and younger adults. This decision was made at the cost of equalizing arousal ratings across the three valence categories, resulting in a stimulus set whose negative images were almost exclusively highly arousing, as illustrated in Table 1. Future investigations would likely benefit from equating arousal across valence categories. Finally, neutral item memory accuracy may be as high as it is due to the disproportionate number of objects included in the neutral category, as compared to the positive and negative categories, demonstrated in Figure 3. This preponderance of object images in a single valence category is true not only for the stimulus set of the current study, but also for the IAPS set as a whole (see Bradley & Lang, 2007). It is possible, although currently uninvestigated, that for the current study, enhanced memory for objects is being confused for enhanced memory for neutral stimuli. If this enhanced object memory (and thereby, enhanced neutral item memory) is exhibited concurrently with a negativity bias (in either the young or older adults, or possibly both), it would create the pattern of the results at hand: the appearance of an “anti-positivity” bias or the illusion of diminished memory for positive stimuli. Previous studies have also met with limited success in eliciting the positivity effect. For example, in analyzing the conditions that do and do not elicit a positivity bias, Tomaszczyk, Fernandes, and MacLeod (2008) found that the self-reported personal relevance of pictorial stimuli affects whether or not an Age X Valence interaction was found. Only when pictures were rated as low in personal relevance did a positivity bias emerge. This same finding was replicated by Fernandes, Ross, Wiegand, & Schryer (2008). Tomaszczyk and her colleagues (2008) took this finding to be a potential explanation for why some studies have found a positivity bias while other very similar studies have not; the materials used in these two types of studies may have differed in their degrees of personal relevance. Clearly, these studies and the present study demonstrate that there are a multitude of potential impediments to uncovering the positivity effect in any study seeking to investigate it.

Moreover, since there is no Mood Induction X Image Valence interaction effect in memory accuracy, the current study also found no evidence for negative mood congruent memory. At the same time, however, the data suggest that the negative mood induction procedure indeed increased negative affect and decreased positive affect significantly, while the neutral mood induction procedure had no clear directional effect on mood. Importantly, analyses also suggest that there were limited or no carryover effects from the negative montage; in other words, it appears that the negative mood induced in participants who saw the negative montage first did not continue on into the time before and after the neutral montage, which decreases the likelihood of confounding.

The emergence of a mood congruence phenomenon was, by no means, guaranteed by the literature to date, particularly for older adults. The vast majority of studies of mood congruent memory exclusively used young adult participants. One of the only studies in the literature that directly assessed the effects of negative mood on the valence of older adults' memory found mood congruence for both young and older adults, although results heavily depended on the particular task under consideration (Knight, Maines, & Robinson, 2002).

As discussed previously, socioemotional selectivity theory contends that older adults are highly motivated to seek meaningful and positive emotional experiences on a daily basis (Carstensen, Isaacowitz, & Charles, 1999). This change in motivation across the lifespan may lead to older adults having more chronically activated emotion regulation goals than young adults (Mather & Knight, 2005), thereby making them more likely to spontaneously employ regulation strategies. Recent findings also provide support for the notion that, when older adults *do* engage in emotion regulation, it is at a lesser cost, in terms of cognitive resources, than it is for young adults (Scheibe & Blanchard-Fields, 2009). These convergent findings are of interest to the current study because previous examinations of mood and emotional memory have found that people who reported high levels of personality traits related to a greater probability of negative mood regulation were more likely to demonstrate mood-*incongruent* memory than individuals low on these same traits (Rusting & DeHart. 2000). If the older adults of the current study spontaneously employed mood repair strategies during the course of the session (emotion regulation, of a sort), this may account for the difficulty in demonstrating mood congruent memory. Future studies would likely benefit from assessing participants' tendencies toward emotion regulation to determine whether or not this is an unconsidered variable influencing the likelihood of mood congruence.

The lack of evidence for mood congruent memory for young adults is still troublesome, however. Using a different type of mood induction procedure, such as hypnosis, the Velten mood induction protocol, odors, or music may result in a different scenario, since all of these procedures have resulted in targeted, specific moods with high ecological validity (Gerrards-Hesse, Spies, & Hesse, 1994). Additionally, including a positive mood induction condition may benefit future studies, since some previous research has suggested that positive mood congruence is easier to elicit than negative mood congruence (Rholes, Riskind, & Lane, 1987).

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Table 1

Number of Low-Arousal and High-Arousal Images in Each Valence Category for Selected Stimuli from IAPS and Newsome and Duarte

	IAPS		Newsome & Duarte	
	Low	High	Low	High
Negative	0	106	3	51
Neutral	51	38	23	48
Positive	43	36	30	51

Note: Arousal ratings for IAPS images taken from Bradley & Lang, 2007 and Gruhn & Scheibe, 2008. Arousal ratings for Newsome & Duarte images taken from Newsome & Duarte, in preparation.

Table 2

PANAS Positive- and Negative-Item Subscores Before and After Montage Viewing, as a Function of Age

		Negative montage				Neutral montage			
		YA		OA		YA		OA	
		Before	After	Before	After	Before	After	Before	After
PANAS subscore	Negative affect	11.93 (2.60)	14.47 (3.76)	11.93 (2.70)	17.21 (5.94)	11.60 (2.03)	10.73 (1.16)	12.57 (5.23)	13.71 (7.04)
	Positive affect	26.60 (9.17)	22.33 (7.76)	35.79 (7.98)	29.71 (10.91)	27.47 (9.23)	23.13 (6.55)	34.50 (7.52)	33.14 (10.07)

Note. Values in parentheses represent standard deviations.

Table 3

Item Memory Accuracy as a Function of Image Valence, Age, and Mood Induction

		Negative montage		Neutral montage	
		YA	OA	YA	OA
Image valence	Negative	0.83 (0.12)	0.64 (0.18)	0.82 (0.11)	0.72 (0.10)
	Neutral	0.83 (0.09)	0.73 (0.15)	0.82 (0.13)	0.72 (0.10)
	Positive	0.79 (0.09)	0.62 (0.15)	0.78 (0.10)	0.65 (0.15)

Notes. Accuracy is defined as hit rate minus false alarm rate. Values in parentheses represent standard deviations.

Table 4

Mean Neuropsychological Task Scores, as a Function of Age

	YA	OA
Letter fluency	45.6 words (10.17)	48.54 words (11.04)
Immediate list recall [a]	11.33 items (0.89)	10.38 items (0.77)
Delayed list recall [a]	11.8 items (0.56)	11.08 items (1.03)
Forward verbal span [b]	7.07 digits (1.16)	7.07 digits (1.19)
Backward verbal span [b]	5.67 digits (1.45)	5.92 digits (1.11)
Trails A	21.95 s (5.69)	30.87 s (10.52)
Trails B	41.06 s (9.87)	54.97 s (10.7)
Visual recognition [c]	19.47 points (0.74)	17.31 points (1.75)
Visual reproduction [d]	9.60 points (0.74)	6.38 points (2.63)

Notes. Values in parentheses represent standard deviations.

[a] Maximum score of 12.

[b] Maximum score of 9.

[c] Maximum score of 20.

[d] Maximum score of 10.

Figure 1. Still captures from the negative mood induction montage.

Figure 2. Still captures from the neutral mood induction montage.

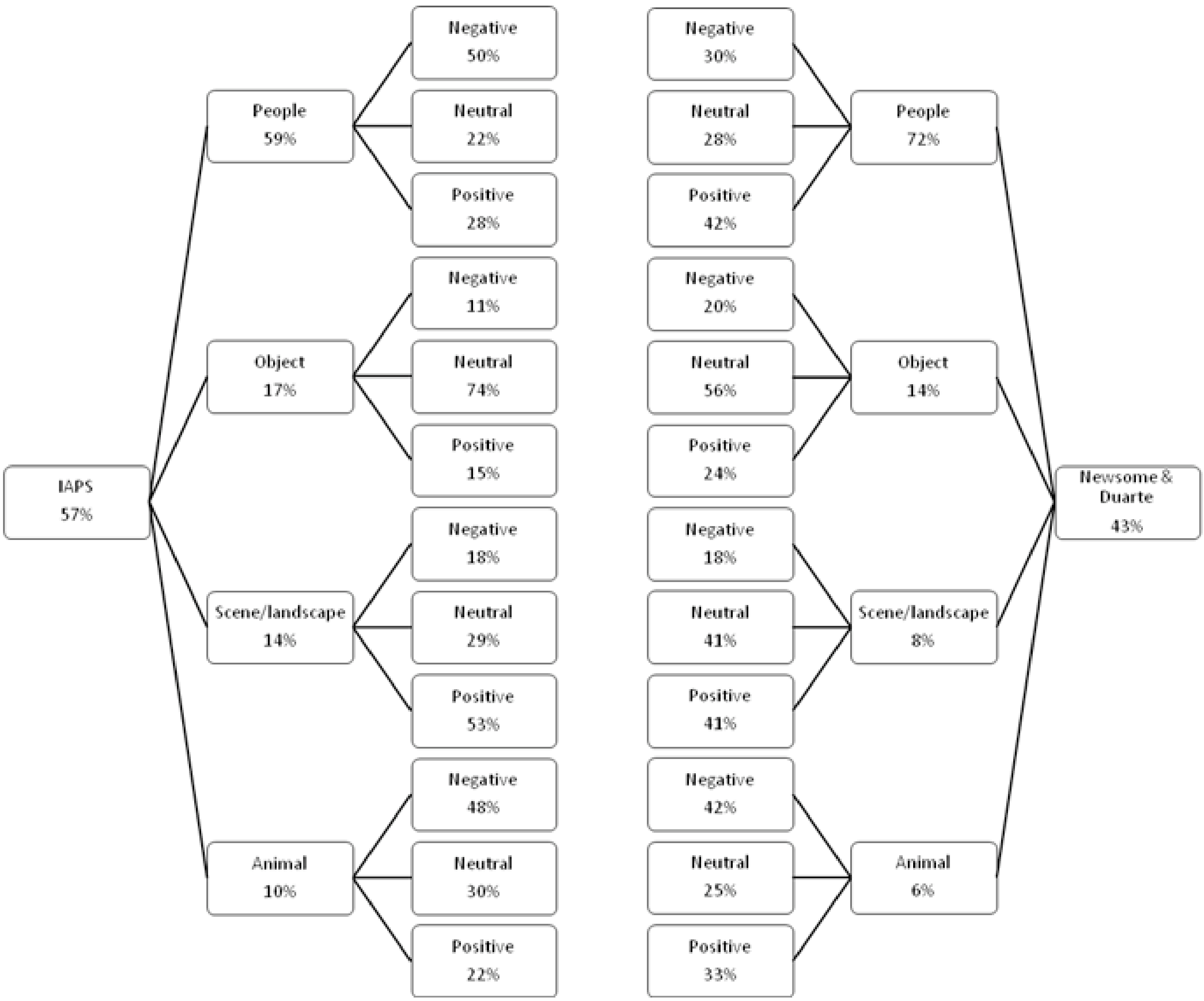

Figure 3. Percentage of pictures in current study which derive from IAPS (Bradley & Lang, 2007) or Newsome and Duarte (in preparation), subdivided by image content and image valence.

Figure 4. A sample negative image.

Figure 5. A sample neutral image.

Figure 6. A sample positive image.

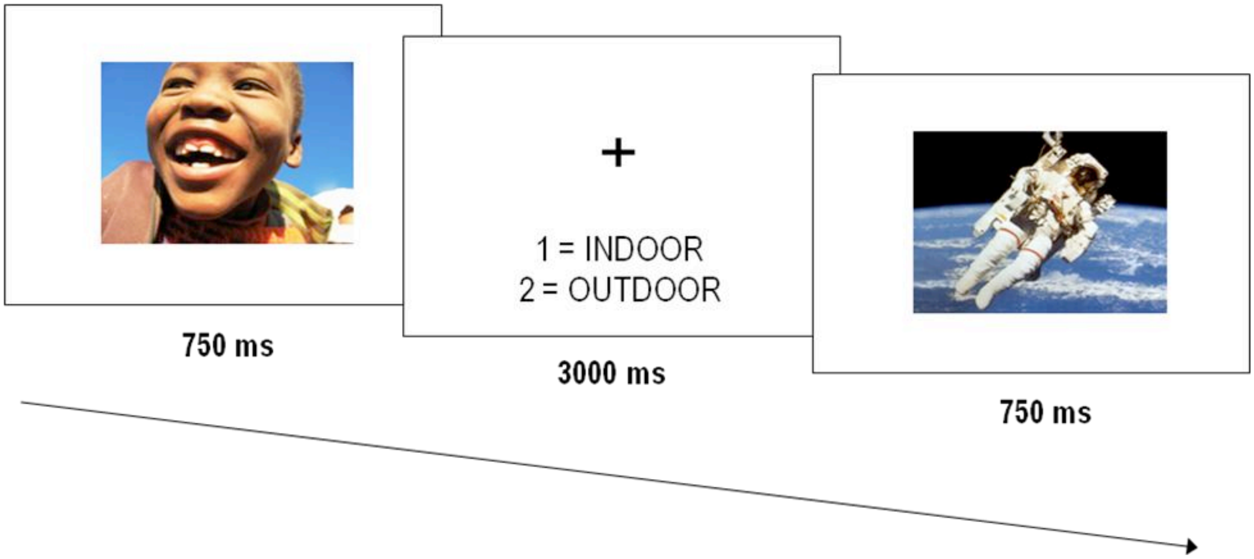

Figure 7. Computer task procedure for study portion of experiment.

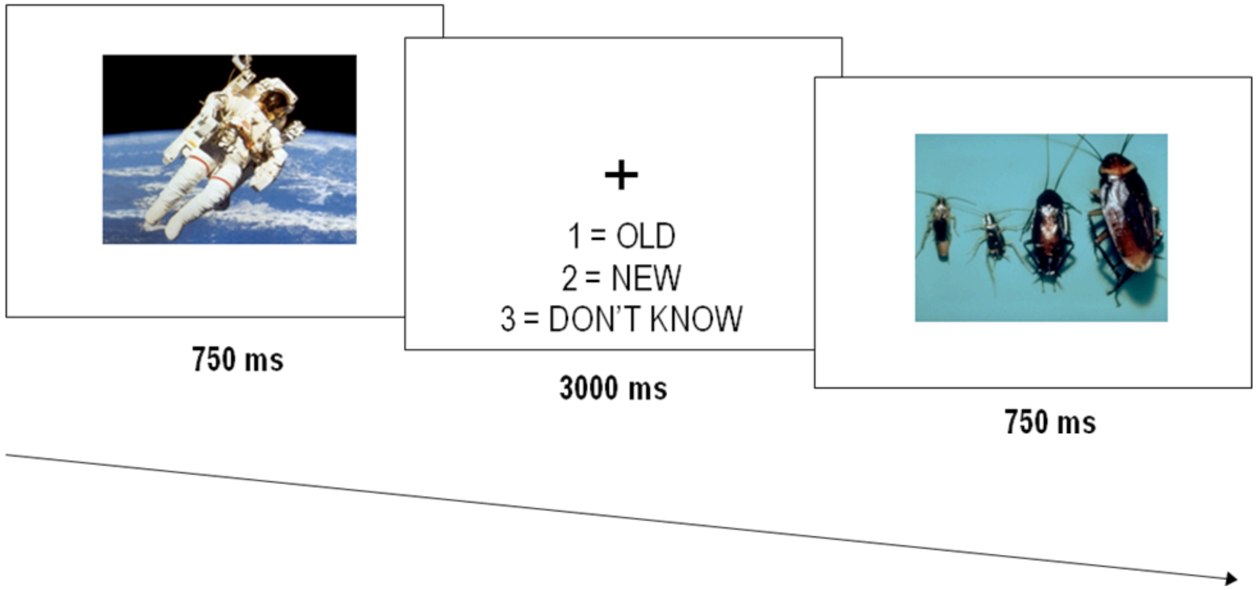

Figure 8. Computer task procedure for test portion of experiment.

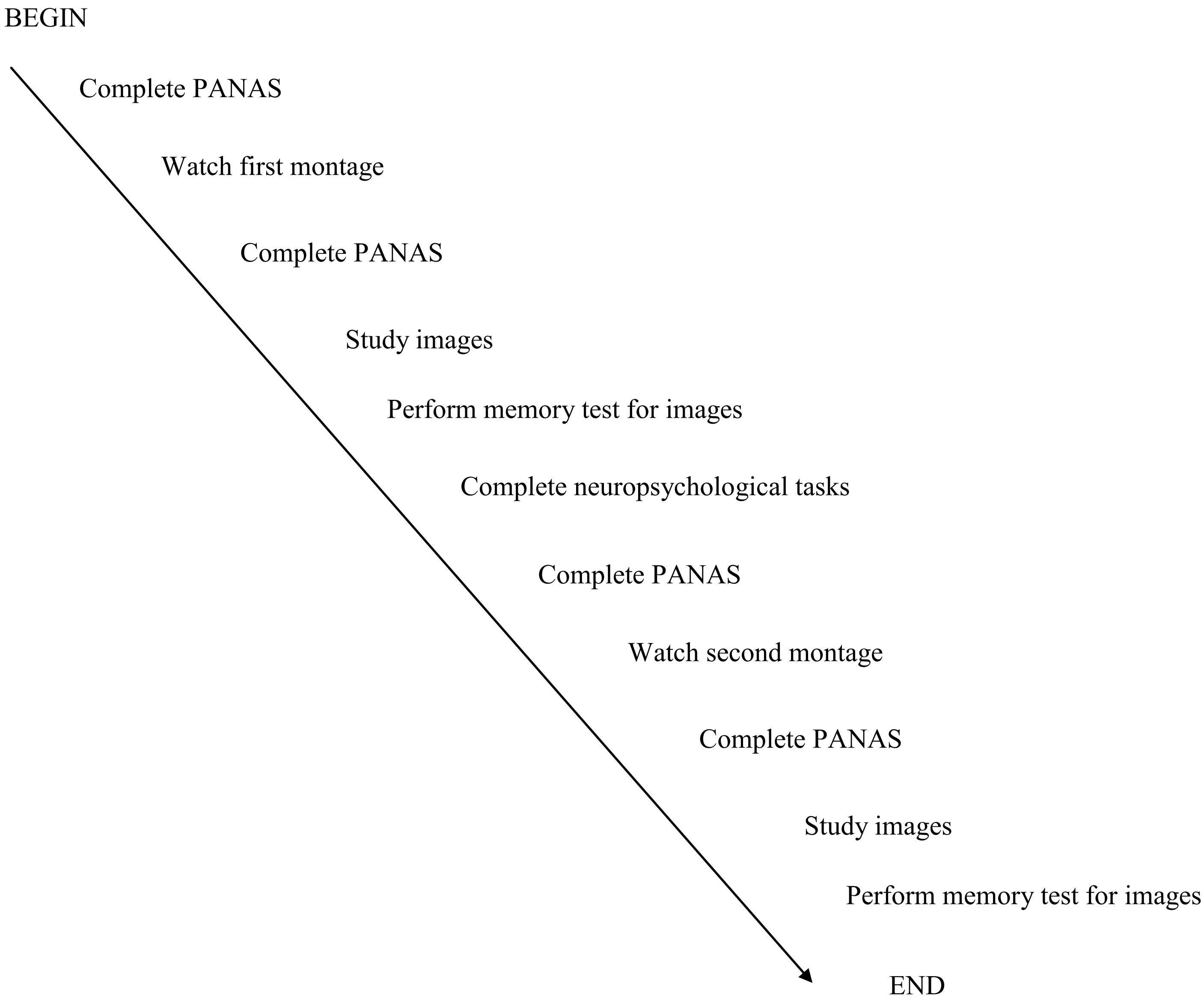

Figure 9. Timeline for each experiment session.

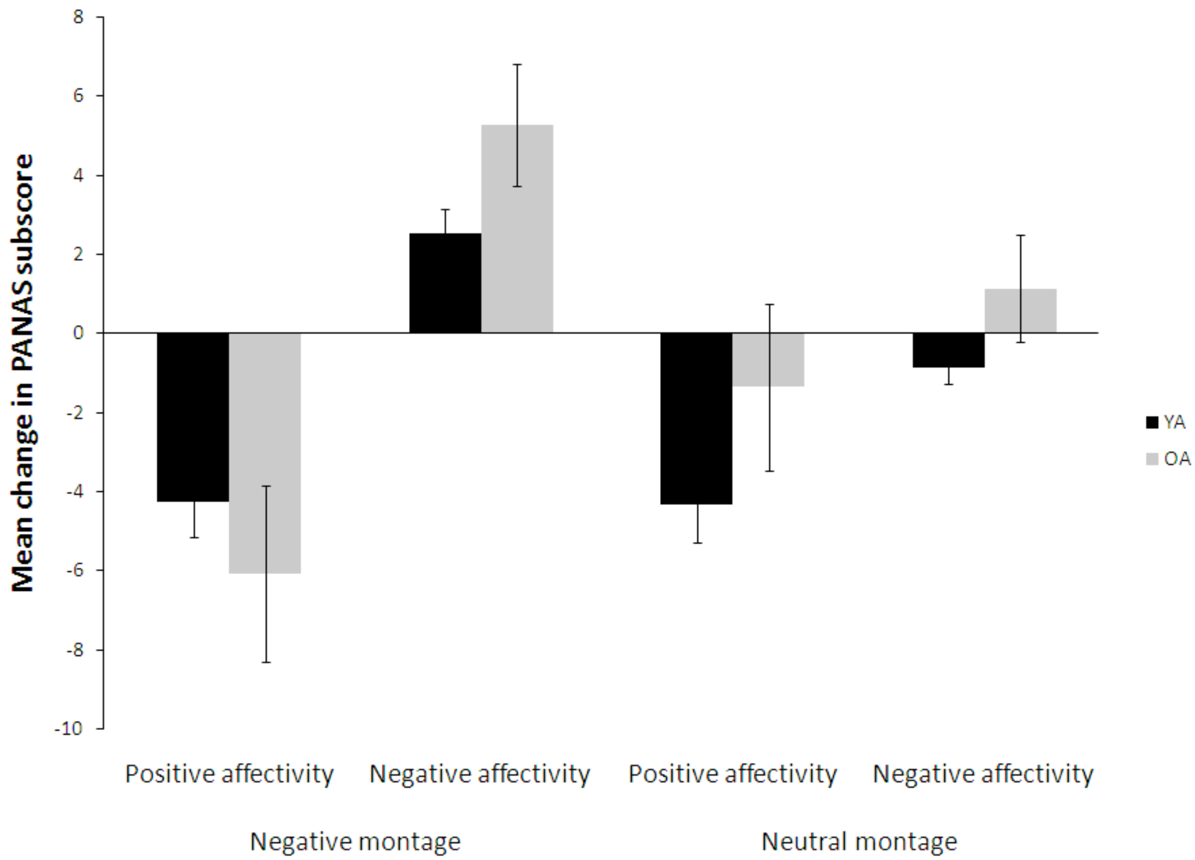

Figure 10. Mean change in PANAS positive- and negative-item subscores, from pre-viewing state to post-viewing state, as a function of mood induction condition and age. Error bars represent standard errors of the mean.

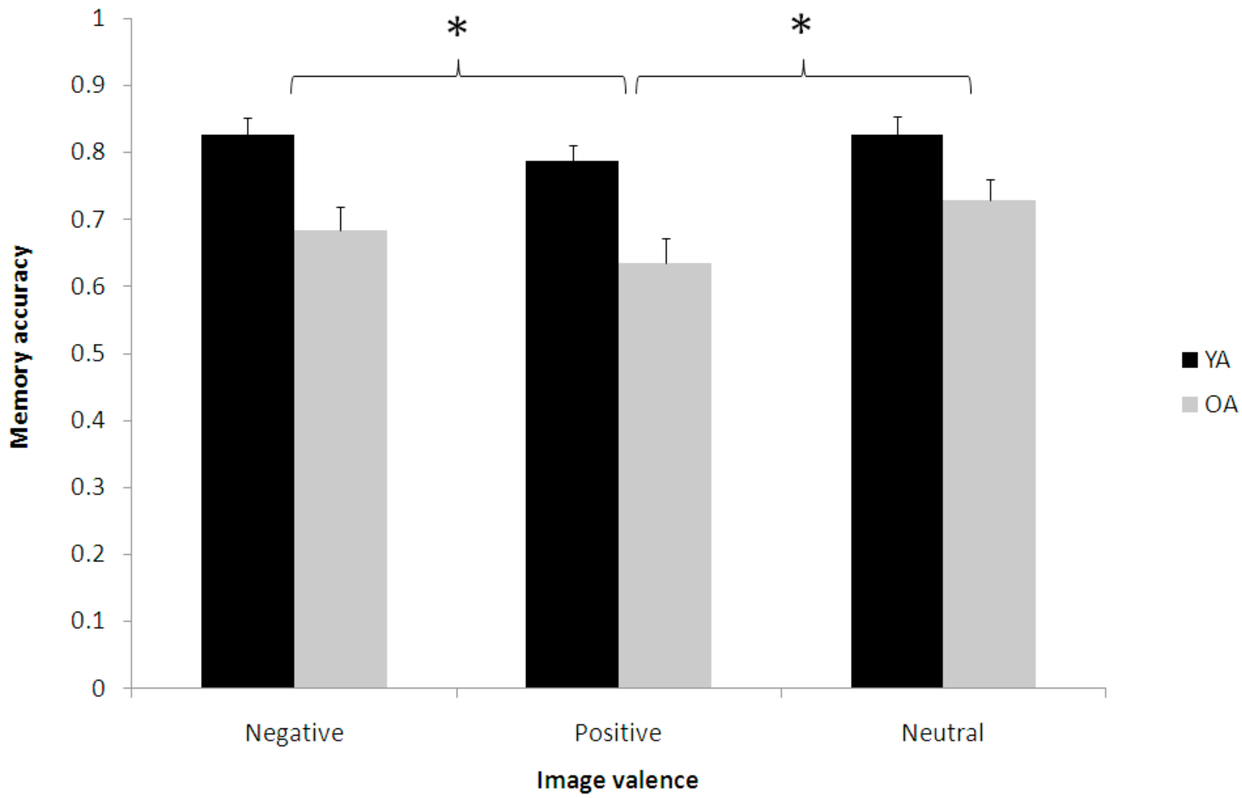

Figure 11. Item memory accuracy, as a function of image valence and age group. Accuracy is defined as hit rate minus false alarm rate. Error bars represent standard errors of the mean. Asterisks indicate significance of $p < 0.05$. Both negative and neutral item memory accuracies were significantly different from positive item accuracy.

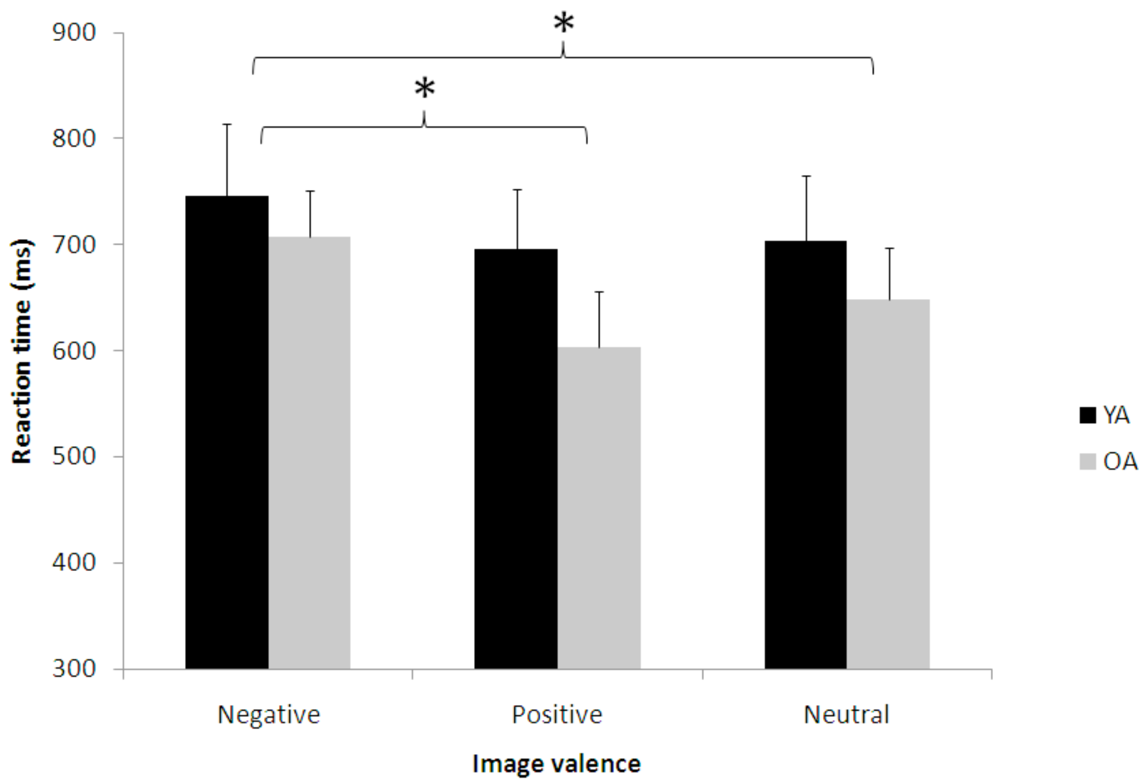

Figure 12. Mean reaction time at study, as a function of age and image valence. Error bars represent standard errors of the mean. Asterisks indicate significance of $p < 0.05$. Reaction times to negative items were significantly higher than reaction times for positive or neutral items.

Appendix A

In the following you will find statements about the way most people feel at one time or another. There is no such thing as a "right" or "wrong" answer, because people are different. All you have to do is answer the statements according to how you have felt during the past week. Don't answer according to how you USUALLY feel, but rather how you have felt DURING THE PAST WEEK. Each statement is followed by four choices. Circle the letter corresponding to your choice. Circle ONLY ONE letter for each statement. For example:

During the past week, I was happy.

a. Rarely or none of the time (less than one day)
b. Some or a little of the time (1-2 days)
c. Occasionally or a moderate amount of time (3-4 days)
d. Most or all of the time (5-7 days)

In the example, you could, of course, choose any ONE of the answers. If you felt really happy, you would choose and circle d. If you felt very unhappy, you would circle a. The b and c answers give you middle choices. Keep these points in mind.

1. Don't spend too much time thinking about your answer. Give the first natural answer as it comes to you.
2. Answer EVERY question, even if it doesn't seem to apply to you very well.
3. Answer as honestly as you can what is true of you. Please do not mark something because it seems like "the right thing to say".

a = Rarely or none of the time (less than one day)

b = Some or a little of the time (1-2 days)

c = Occasionally or a moderate amount of time (3-4 days)

d = most or all of the time (5-7 days)

1. During the past week, I was bothered by things that usually don't bother me.	a	b	c	d
2. During the past week, I did not feel like eating; my appetite was poor.	a	b	c	d
3. During the past week, I felt that I could not shake off the blues even with help from my family or friends.	a	b	c	d

4. During the past week, I felt that I was just as good as other people.	a	b	c	d
5. During the past week, I had trouble keeping my mind on what I was doing.	a	b	c	d
6. During the past week, I felt depressed.	a	b	c	d
7. During the past week, I felt that everything I did was an effort.	a	b	c	d
8. During the past week, I felt hopeful about the future.	a	b	c	d
9. During the past week, I thought my life had been a failure.	a	b	c	d
10. During the past week, I felt fearful.	a	b	c	d
11. During the past week, my sleep was restless.	a	b	c	d
12. During the past week, I was happy.	a	b	c	d
13. During the past week, I talked less than usual.	a	b	c	d
14. During the past week, I felt lonely.	a	b	c	d
15. During the past week, people were unfriendly.	a	b	c	d
16. During the past week, I enjoyed life.	a	b	c	d
17. During the past week, I had crying spells.	a	b	c	d
18. During the past week, I felt sad.	a	b	c	d
19. During the past week, I felt that people dislike me.	a	b	c	d
20. During the past week, I could not get "going".	a	b	c	d

Appendix B

Directions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to that word. Indicate to what extent you feel that way RIGHT NOW.

Use the following scale to record your answers:

(1) = Very slightly or not at all
(2) = A little
(3) = Moderately
(4) = Quite a bit
(5) = Extremely

	Very Slightly Or Not At All	A Little	Moderately	Quite a bit	Extremely
1. Interested	1	2	3	4	5
2. Distressed	1	2	3	4	5
3. Excited	1	2	3	4	5
4. Upset	1	2	3	4	5
5. Strong	1	2	3	4	5
6. Guilty	1	2	3	4	5
7. Scared	1	2	3	4	5
8. Hostile	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Proud	1	2	3	4	5
11. Irritable	1	2	3	4	5
12. Alert	1	2	3	4	5
13. Ashamed	1	2	3	4	5
14. Inspired	1	2	3	4	5
15. Nervous	1	2	3	4	5
16. Determined	1	2	3	4	5
17. Attentive	1	2	3	4	5
18. Jittery	1	2	3	4	5
19. Active	1	2	3	4	5
20. Afraid	1	2	3	4	5

Appendix C

Images selected from IAPS

1050	2375.1	3022	5780	7053	8060	9265
1201	2381	3051	5781	7055	8090	9270
1230	2383	3062	5811	7059	8116	9280
1274	2385	3101	5814	7060	8185	9290
1300	2387	3150	5830	7080	8186	9320
1303	2391	3160	5831	7090	8200	9331
1310	2393	3170	5891	7100	8210	9342
1463	2395	3181	5920	7150	8230	9400
1500	2397	3215	5971	7161	8232	9405
1525	2398	3220	6022	7175	8350	9415
1590	2399	3230	6150	7180	8370	9419
1603	2410	3250	6212	7184	8371	9420
1616	2480	3350	6213	7207	8380	9423
1620	2499	3400	6230	7220	8400	9424
1670	2501	3500	6300	7224	8420	9425
1721	2510	3550.2	6311	7233	8461	9426
1920	2516	4233	6315	7235	8470	9428
1930	2550	4599	6360	7248	8475	9430
1935	2590	4601	6415	7260	8480	9433
1945	2595	4613	6510	7280	8490	9435
1999	2598	4622	6560	7325	8496	9470
2091	2655	4640	6571	7350	8497	9490
2120	2683	4700	6821	7359	8503	9500
2141	2690	5001	6825	7380	8531	9530
2190	2691	5010	6831	7410	8540	9571
2200	2692	5200	6834	7430	9000	9600
2214	2700	5201	6838	7480	9006	9611
2216	2716	5220	6910	7487	9007	9622
2220	2717	5260	7000	7493	9010	9630
2224	2745.1	5460	7002	7508	9041	9635.1
2230	2749	5470	7004	7546	9042	9800
2272	2750	5480	7010	7570	9050	9810
2303	2751	5551	7020	7590	9090	9830
2306	2753	5594	7025	7595	9120	9900
2310	2780	5611	7030	7640	9140	
2311	2799	5623	7040	7705	9180	
2332	2800	5631	7041	7820	9181	
2352.1	2900	5700	7043	7920	9190	
2370	3005.1	5740	7050	7950	9250	
2373	3017	5779	7052	8034	9254	